Khanty-Mansiysk
Autonomous Okrug – Yugra

State core storage facility of the
Khanty-Mansiysk Autonomous Okrug – Yugra

ЦИК

CORE RESEARCH CENTRE

ЦИК ЦЕНТР ИССЛЕДОВАНИЙ КЕРНА
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In 2018, an agreement was signed between Bazhen Technology Centre, LLC (Gazprom Neft, PJSC) and Autonomous Institution of the Khanty-Mansiysk Autonomous Okrug – Yugra "V.I. Shpilman Research and Analytical Centre for the Rational Use of the Subsoil" on establishment of the

CORE RESEARCH CENTRE (CRC)

the basis of the regional state core storage facility with the support of the Government of the Khanty-Mansiysk Autonomous Okrug – Yugra.

Within the framework of the national project "Bazhen", it is planned to introduce the most promising methods for developing hard-to-recover reserves in the territory of the Russian Federation. The basis of the works consists of a full cycle of core research, the results of which provide high accuracy of forecasts and consequently the efficiency of the proposed field development methods.

Practice shows that fundamental knowledge of the target of research is needed to achieve a positive geological and economic effect and to develop a strategy for rational positioning of the boreholes. This knowledge can be obtained from core studies at seven key levels:

I – primary works with whole core.

Special careful transportation of the extracted rock material to the laboratories of the enterprise is noted as an important element. In addition, it is important to properly carry out works on systematization of core material, preparation of the primary documentation, its inter-connection, revision, interval description and reference of core to GIS. The components mentioned above are necessary for maximum preservation of the natural integrity of core and, as a result, determine its suitability for further complex studies. Employees of the Core Research Centre are ready to travel to the field to accompany the research process from the «very first step».

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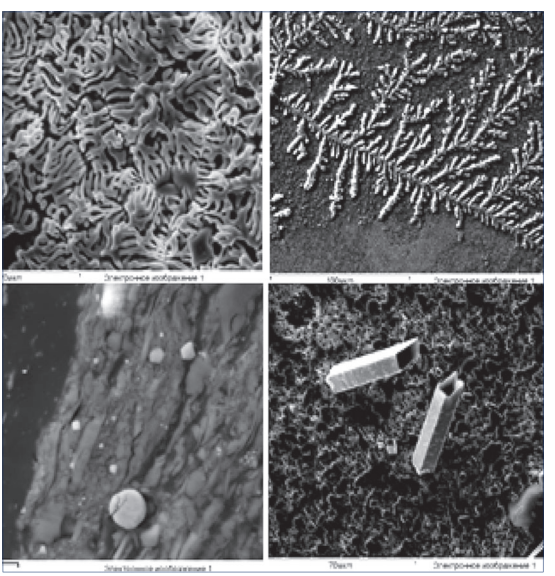
II – complex sample preparation.

At the second level, before core sawing, it is advisable to perform works on profile gamma-recording to evaluate the studied sediment section and to refer the sites of rocks sampling, followed by tomography of the whole core. Further, after sawing, the detailed description of the core and its lithotypization, daylight and ultraviolet photographing, fluorescence analysis and sampling for complex laboratory studies, which are impossible without proper quality sample preparation, are carried out.

III – identification of material composition of the studied rocks.



The third level is devoted to the qualitative and quantitative study / identification of the rock material composition. The obtained data is an important element in determining the type of rock and consequently in conducting facial zoning within the target of research in order to identify areas of distribution (replacement / pinching out) of reservoir rocks, as well as localization of the new perspective targets for oil and gas exploration.

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NITON XL3t 950 GOLDD *Spectrometer portable (Thermo Fisher Scientific, Switzerland)*

X-ray fluorescence analysis (identification of content of the chemical elements) of core samples (ground samples, splinters, and unsawn core). The analysis of other geological samples, as well as environmental objects is possible.

ARL PERFORM'X *X-ray Fluorescence Spectrometer (Thermo Fisher Scientific, Switzerland)*

Identification of elemental composition (from fluorine (F) to uranium (U)) of solid, liquid and powder samples of various objects (oil, core material, formation water, rocks, soil, bottom sediments, environmental objects, and salt deposits). Elemental mapping of the surface of samples with 3D and 2D imaging.

Vaneox *Automated Press*

Automated pressing of powder samples into tablets for X-ray fluorescence analysis.

Liston *Laboratory Centrifuge*

Used in the process of sample preparation for manufacture of clay fraction preparations.

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EVO 50 *Microscope (Carl Zeiss, Germany) equipped with Inca Energy 350 energy dispersive spectrometer (Oxford Instruments, UK)*

Analysis of the sample surface with image patterning. Elemental mapping of sample surface.

SEM Mill sample Model 1060 *Ion Etching System (Fischione Instruments, USA)*

Precision finish of core sample surface for subsequent analysis using scanning electron microscopy.

Katanax X300 *Electric Fusion Furnace*

Automated preparation of glass discs by fusing sample with flux for X-ray fluorescence analysis.

ARL X`TRA *Diffractometer (Thermo Fisher Scientific, Switzerland)*

Identification of the mineralogical composition of core by X-ray diffraction: analysis of solid, liquid and powder samples; detection and identification of phases with volume ratio exceeding 0.1 %; determination of phase composition; quantitative identification of known phases in the mixture.

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IV – identification of petrophysical features.

Within the framework of the fourth level, all possible physical characteristics of the studied sediments are specified. Studies carried out on standard samples and on whole core. Identification of petrophysical dependencies is a key step in justification of parameters for estimating the oil and gas reserves, these data are used in three-dimensional geological and hydrodynamic modelling, searching for methods to enhance oil recovery, as well as in studying the effect of various drilling fluids, and killing fluids on changes in reservoir properties of rocks.

V – strength parameters.

The fifth level of core research is referred to the study of the characteristics of the physical and mechanical properties of rocks. Modern approaches using geomechanical modeling enable reducing the costs of drilling process non-production time, which is achieved by improving the quality of assessment and control over stability of the walls of the wellbore during drilling and operation; by determining the optimal direction of drilling and the angle of entry into the reservoir, as well as by improving the accuracy of forecast parameters in the drilling process and optimizing the drilling program in real time. In addition, these studies are necessary for successful implementation of formation hydraulic fracturing traditionally used in the development of low permeability reservoir rocks.

VI – geochemical characteristics of sediments.

It is advisable to evaluate the oil and gas potential of the studied area taking into account the separation of parts of the sediment section sufficiently enriched in organic matter, i.e. to perform a complex of geochemical core studies, which corresponds to the sixth level of work. This level includes kinetic studies of organic matter of oil source rocks, determination of vitrinite reflectance, core pyrolytic studies, etc. The results of the sixth level provides an idea about concentration of organic carbon, types of initial organic matter that is accumulated in the sedimentation basin, which

in its turn predetermines the course of catagenesis, composition of the generated hydrocarbons and ultimately the oil and gas source potential of sedimentation mass.

For the purposes of petroleum geochemistry, CRC has a set of equipment for sample preparation – a system of accelerated extraction of rocks, soils, bottom sediments, ecological and food objects in automatic mode with different polarity solvents and obtaining the corresponding separate fractions of the selected groups of substances; selective extraction of the required groups of organic substances using different adsorbents; obtaining powder samples after extraction.

The system is equipped with collection of extracts in the adapted vials for subsequent concentration using a Rocket Evaporator vacuum centrifugal evaporator and further types of studies:

– Quantitative determination of the mass fraction of bitumoid in rock samples;

– Isolation of bitumoid for the subsequent group (material) compositional analysis: quantitative determination of asphaltenes, resins and hydrocarbon (oil) fraction by gravimetric and liquid adsorption methods;

– Isolation of bitumoid (or selective fractions of bitumoid) for the subsequent chromatography-mass-spectrometric study of individual composition of the organic substances;

– Obtaining debituminized extracts for subsequent pyrolytic analysis of residual organic matter;

– Biomarker analysis of oils and bitumoids;

– Correlation studies of oil-rock;

– Geochemical characteristics of oil and gas source rocks;

– According to the results of the study, the conditions for formation of organic matter are evaluated;

– Genetic classification of oils;

– HC source of generation and travel paths are determined;

– Oil trap productivity is predicted.

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Dionex ASE 350 *Accelerated Solvent Extractor System (ThermoFisherScientific, USA)*

Automatic extraction from various powdered substances with capability of sequential extraction with different polarity solvents and obtaining the corresponding separate fractions of the selected groups of substances, selective extraction of the required groups of organic substances using different adsorbents, obtaining powder samples after extraction.

Rocket Evaporator *Vacuum Centrifugal Evaporator (SPScientific, USA)*

Concentration (evaporation) of liquid extracts received with ASE 350 Dionex Accelerated Extractor with capability of direct automated collection of concentrate into special vials for subsequent types of studies. Regeneration (distillation) of waste solvents is an additional purpose.

Pyroprobe CDS 6150 *Thermal Desorption System (CDS Analytical LLC, Oxford, USA)*

Automated desorption of organic components from powder samples directly into the chromato-mass spectrometer, which, unlike classical pyrolysis providing information only about the group composition, allows for a detailed analysis of the individual composition of the desorbed HC and other OMs contained in pyrolysate under various thermal conditions. This complements and / or more correctly interprets the results of classical pyrolysis according to the main pyrolytic parameters.

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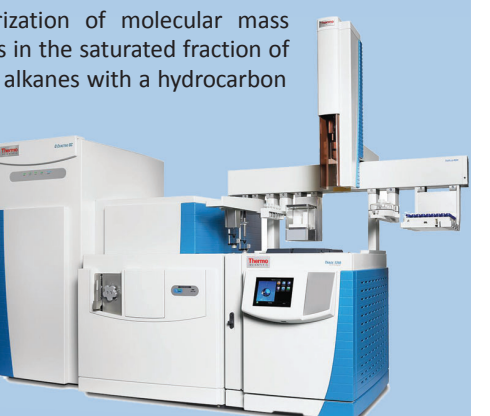
HAWK Resource Workstation *Automated workstation (Hydrocarbon Analyzer With Kinetics, Wildcat Technologies, USA)*

Pyrolytic core studies (definition of S_0 (C_1-C_7), S_1 (C_8-C_{15+}), S_2, S_3, S_3', S_3CO, $S_3'CO$, Tmax, PI, HI, OI, Min C, PC, RC, S_4CO_2, S_4CO, S_5, AI, OSI). Kinetic studies.

Qualitative and quantitative high-sensitivity analysis of the composition of liquid samples, powder geological and other samples (in combination with Pyroprobe CDS 6150 Thermal Desorption System), in a wide dynamic range (from ppm fractions up to 100 %). For the purposes of petroleum geochemistry, this instrument allows for the analysis of the saturated or aromatic streams of hydrocarbon composition of oils and bitumoids of rocks (extracts) in the scanning mode for total ion current (TIC), selected ion monitoring (SIM), and ion products monitoring in the study of organic components of the extract with trace levels of their content.

Study of composition and characterization of molecular mass distribution of biomarker hydrocarbons in the saturated fraction of the bitumoid of rocks and oils: normal alkanes with a hydrocarbon chain length from C_7 to C_{40}; acyclic isoprenoids (prystane, phytane); polycyclic naphthenes (triterpanes, hopanes, steranes).

Study of composition and characterization of molecular mass distribution of hydrocarbons of the aromatic streams of the bitumoid of rocks and oils: alkyl benzenes, alkyl naphthalenes, alkyl phenanthrenes, other polyaromatic hydrocarbons with 4-6 aromatic rings in molecule structure.



TSQ 8000 EVO *Mass Spectrometer with Trace 1310 Gas Chromatograph (ThermoFisherScientific, USA)*

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VII – geochemical characteristics of sediments.

The seventh level of research consists of studying the physicochemical characteristics of reservoir fluids, such as density, viscosity, refraction properties, saturated vapor pressure, coke residue, flash point in open and closed crucible, fractional composition with chromatographic, spectral, electrochemical, X-ray and many other analysis methods. The elemental and ionic composition of fluids and solid samples and their water content are determined. In addition, there is equipment to determine the product characteristics of oil for compliance with the global and national standards. All studies are carried out by highly qualified specialists responsible for completeness, correctness of testing and compliance with the requirements of regulatory documents for the implementation of measurement procedures.

The obtained information can be used, first of all, in calculation of reserves, as well as in preparation and adaptation of the hydrodynamic model required for the rational positioning of the boreholes.

The Core Research Centre is being equipped with modern diagnostic equipment complexes by such global manufacturers as Anton Paar, Metrohm, EuroDist, Thermo Fisher Scientific, etc., which allows for determining the main technical and operational indicators with high accuracy and in a short time.

The set of results for all the above-described levels of core research enables us to predict areas of industrial accumulation of hydrocarbon raw materials that can be concentrated within the development of low-permeability reservoir rocks and have not been previously involved in development.

CRC's Laboratories of:

1. Core and sludge collection, processing, and storage.
2. Core and sludge studies.
3. Core geochemical studies.
4. Chromatographic research methods.
5. Studies of reservoir fluids properties.
6. Regional core storage information technologies.
7. Studies of reservoir mechanical properties.
8. Hydraulic fracture modeling.

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940 Professional IC Vario
Ion Chromatograph

Analysis of reservoir and other types of water to determine the anionic (F, Cl, Br, I, NO_3, NO_2, SO_4, PO_4) and cationic (NH_4, Ca, Mg, Li, K, Na ...) composition.

852 Titrando
Volumetric and Coulometric Titration System

Multifunctional device enabling determination of water within range from 0.0001 to 100%.

EURODIST System TBP 10L
Automatic combined installation for determining the fractional composition of oil and heavy fractions

Automatic installation for distillation of crude oil into fractions at boiling points up to 400 °C under atmospheric conditions and in vacuum.

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